Analysis and Elimination Strategy of Scan Blindness in a T-type Printed Dipole Phased Array

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Scan blindness effect is critical issue in a phased array antenna. It causes gain degradation and reduces the efficiency of an antenna. If an infinite phased array structure is capable of supporting a guided wave, then under certain Floquet excitations, the guided mode may be strongly excited. [A. K. Bhattacharyya, Phased Array Antennas—Floquet Analysis, Synthesis, BFN and Active Array Systems, 2006.] It is well known that the planar printed dipole patch excites surface wave modes on the substrate and is shown to predict the occurrence of scan blindness. To remove the scan blindness, electromagnetic bandgap (EBG) materials are the most efficient approach [L. Zhang et al., IEEE TAP, 2000-2007, 2004]. Unlike a patch type printed dipole, a T-type printed dipole array excites other mode resonance at scan blindness angle. In this presentation, we examine the scan blindness for T-type printed dipole phased array and propose the elimination strategy of its effect.

T-type printed dipole antenna is one of the most commonly used antenna in millimeter wave (mmW) band such as Ka-band radar systems and 5G communications because it is easy to implement. We consider that the printed dipole is infinite array in rectangular grid and its cell size is half wavelength at the operating frequency. Antenna is designed by using the Duroid 5880 substrate which is widely used for mmW phased array. Scan blindness effect can be observed through the Active Element Pattern (AEP) using FEM simulation. The scan blindness of the designed dipole array antenna occurs around 36 degrees of the E-plane. Simulation shows that common mode currents occur in the dipoles at the scan blind angle. At this time, it can be seen that the E-field and the H-field are strongly distributed around the loop which is structurally formed between two adjacent dipole antennas. Based on the results, it is considered that the Floquet mode excites in the split loop at scan blind angle and the array cannot be radiated.

To avoid the resonance at the operating frequency, geometrical modification of the printed dipole is required. Increasing the cell size can be considered as a way to lower the resonance frequency because the loop size also increases. However, there is a drawback that the array size increases and a grating lobe occurs. So we propose two ways to move the resonance frequency without changing the cell size. The first method is to add an open stub between two adjacent antennas. Because the open stub increases the capacitance in the loop, the resonant frequency is reduced. The second is to add a slit to both ends of the antenna. As the slit increases the inductance of the loop, the resonant frequency is also reduced.

In this study, we present that the cause of scan blindness of T-type printed dipole is loop resonance by common mode current. To solve the resonance problem, it has been introduced that a method of lowering the resonance frequency by adding a stub or a slit. In order to verify the improvement of scan blindness by applying the above methods, a finite array antenna will be fabricated and discussed.